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RADIOLOGICAL ASPECTS OF CERTAIN TROPICAL DISEASES*†

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THE airplane and the current world war have forced us to acquire a more active interest in certain diseases of other lands. Clinical information concerning some of these diseases is still relatively meager, especially as concerns their manifestations in otherwise healthy white men (subject to relatively brief or mild exposure). For this reason it may be timely to review the radiological aspects of some of the more common tropical and semi-tropical disorders, and to consider current opinions as to the value of irradiation therapy in one or two of them.

DENGUE

Dengue is one of the most important tropical diseases as far as morbidity is concerned. The radiologist should be aware of its clinical features, despite the fact that there are no characteristic x-ray findings. Patients usually show a high fever, severe pains in the joints and muscles, and leucopenia; some develop a rash and adenopathy. Many have pains referred to the eyeballs, with or without conjunctivitis. The disease is due to a virus transmitted by the Aëdes mosquito.

DYSENTERY

Bacillary dysentery. This disease, due to various species of shigellae, is of widespread distribution and may result in serious epidemics. In the acute stage, there are no findings of specific radiological interest. In the chronic stage, x-ray changes resembling those of *chronic ulcerative colitis* have been reported.

Amebic dysentery. This form, due to endameba histolytica, is also world-wide in distribution, but more common in tropical than in temperate regions. It may be acute or chronic; carriers are common. The chronic form sometimes shows features of radiologic importance:

a. *Colon:* Irritability and mucosal irregularities, especially in the proximal half of the large bowel. Occasional hyperplastic changes in the cecum and appendix. Some believe that cecal inflammatory changes without pulmonary disease should suggest amebic colitis. Bell[1] reported conical spasm of the cecum, with segmental irritability of the colon in a group of cases.

b. *Liver:* Enlargement of one or more lobes, with associated displacement of the colon or stomach, may be due to liver abscess. We have found this observation of gastric displacement of considerable value in two cases of amebic abscess of the left lobe of the liver. These abscesses may be single or multiple, and sometimes attain enormous size. Thorotrast hepatography will help in their localization.

c. *Lung:* Abscess of the lung, silent or otherwise, may occur, often by extension from a liver abscess. There are no pathognomonic x-ray findings.

d. Miscellaneous: Abscesses of the *brain* and other viscers are occasionally seen.

TYPHUS AND OTHER RICKETTSIAL DISEASES

These diseases, while of considerable clinical importance, present no roentgen findings of immediate interest with the possible exception of Q fever. In that disease, due to rickettsia diaporica or burneti, a patchy type of *bronchopneumonia,* confined to one lobe, has been reported. In scrub typhus or tsutsugamushi disease, variable degrees of myocardial dysfunction may ensue; suitable roentgen studies (including kymography) will often disclose evidence of *cardiac damage* in involved cases.

HELMINTHIASIS

This includes a large group of disorders, many of them nontropical in nature. Only the more important ones, which show some findings of radiologic importance, will be considered here.

Hookworm disease. This is usually due to Necator americanus or ankylostoma duodenale. In the former, *small bowel* changes similar to those seen in deficiency disorders, have been reported.[2] They may subside following vermifugation. In ankylostomiasis, patients may have symptoms of duodenal ulcer, apparently due to the presence of numerous hooklets in the duodenal bulb, with associated *duodenitis.*[3] The thickened mucous membrane, irritability and local tenderness disappear soon after administration of a vermifuge. We have seen only a few cases with such findings.

Strongyloidiasis. Due to strongyloides stercoralis, this infestation usually results merely in diarrhea. However, changes in the small bowel suggesting regional *ileitis,* and in the lungs (localized infiltrates) have been reported.[4]

Ascariasis. This is the commonest helminthic infection. The worms may be recognized in the course of a gastrointestinal examination as radiolucent shadows, occurring especially in the jejunum. They measure from 15 to 30 cm. in length and about 6 mm. in diameter. The gastrointestinal tract of the worm itself may be outlined with the host's barium at a twelve or twenty-four hour study. Occasionally, a bolus of worms causes intestinal obstruction.

It is of interest to note that the actual incidence of intestinal parasitism in Naval personnel returning from the Pacific theatre in the years 1942 and 1943 was quite low, according to Michael,[5] who published a brief table showing the then percentage distribution of the conditions.

TRYPANOSOMIASIS

There are two completely different forms of this disease, the African and the American. African trypanosoma rhodensiense, causes sleeping sickness, with its associated hepatosplenic enlargement. American trypanosomiasis, due to trypanosoma cruze, causes Chagas' disease, with acute or chronic cardiac disturbances. The African type is, of course, the greater health problem. No important or characteristic x-ray changes have been reported.

LEISHMANIASIS

Due to a minute parasite, the leishmania, this disease may be predominately visceral or cutaneous. The former, or Kala-azar, shows fever, anemia and hepatosplenic enlargement. It may be mistaken for malaria. Complications are numerous and frequently severe: they include pulmonary, intestinal and vascular disturbances. Cutaneous leishmaniasis appears in two forms: the oriental and the American. Both show ulcerating granulomas of the skin, especially of the face and upper extremities. The

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† The publication of matter pertaining to one of the most important of these diseases is temporarily restricted by a directive of the Joint Security Control Board. The others will be considered in the approximate order of their clinico-pathological importance at the present time.

American type or espundia, shows mucosal lesions as well. It is common in South America. No characteristic x-ray changes have been reported.

FILARIASIS

Three different forms of filariasis are seen in men, the most important being that due to the minute worm formerly known as the filaria bancrofti but now known by the cumbersome title Wuchereria bancrofti. This is the most widely distributed of the filarial diseases, and is spread by several different species of mosquito.

Filariasis. Filariasis due to Wuchereria bancrofti and to Wuchereria malayi is of considerable interest to radiologists, both from the point of view of diagnosis and treatment. The incubation period varies widely, being usually from 3 to 12 months. In otherwise healthy adult white males, not subject to heavy or repeated infection, it may present few or *no* clinical symptoms. When symptoms are present, they usually consist of periodic attacks of superficial lymphangitis involving an arm or leg, with variable degrees of lymphadenitis. The lymphangitis is frequently "retrograde," extending distally from the point of initial development. Attacks of funiculitis, epididymitis and orchitis commonly occur. Hydrocele or scrotal edema may develop. These attacks of lymphangitis may be mild or very painful. They usually subside in a week or two, and may not recur for months or years. Some cases show repeated recurrences at short intervals. Edema, wheals and other allergic phenomena are seen.

After several attacks of lymphangitis, persistent edema and fibrosis *may* develop and the condition of elephantiasis appear. Such usually takes several years, and seems to occur chiefly in those who have sustained prolonged exposure, massive infestation or complicating pyogenic infection. In the late stages, chyluria, chylous ascites and chylous diarrhea may occur. Chyluria (probably better known as lymphuria) is due to rupture of dilated blocked lymphatics into the renal pelvis or ureters. If blood vessels rupture along with the lymphatics hematolymphuria results. Some cases of chyluria show no symptoms; others have marked weakness, abdominal pain and depression. The deformity of the renal pelvis produced by the dilated lymphatics has been correctly diagnosed by urography.

In some patients the worms die and become calcified, producing small opacities, especially in the subcutaneous tissues, lymph nodes and the scrotal lymphatics. These appear as small linear or dot-like shadows from 1 to 4 mm. in length and only about 1 mm. in diameter. Some observers have reported opacities up to 12 mm. in length.[6] They are often difficult to recognize, but are fairly characteristic, having a different distribution from calcified trichinae, and being much smaller than cysticerci.[7] We have x-rayed the extremities and scrotal areas of about one hundred cases of filariasis in white adult males, all with infections of less than two years duration, without succeeding in demonstrating calcified worms in any of them. The worms are said to live from 1 to 7 years and probably few were adequately calcified, even if dead, in the short time elapsing since infection in our cases. The female worm measures up to 6 cm. in length and 0.25 mm. in thickness; the male is about half that size. They are often found coiled up in a node and occasionally in a thickened lymphatic. They have been recovered alive from infected nodes, by immersion of the excised node in warm saline for several hours; the worm resembles a small piece of white thread.

It is to be noted that the outstanding symptom and sign of filariasis is *lymphangitis*, and that the microfilariae are rarely discovered in the blood in the early stages of the disease, at least in current cases of W. bancrofti infestation arriving from the South Pacific area. Diagnostic skin tests are under investigation but no really satisfactory one has yet been reported. Some authorities regard biopsy of involved nodes as inadvisable because of a tendency to initiate recurrences. A reliable skin test will therefore be all the more desirable.

In those patients who have significant pain, soreness or other disability associated with the attacks of lymphangitis or lymphadenitis, considerable palliation and actual arrest of an attack can often be secured by irradiation of the involved areas. We use small doses administered to wide fields (from 50 to 100 r, air, with fields not less than 20x20 cm.), and radiation with moderate filtration, half-value layer equivalent to about 0.5 mm. copper. This dose is given to the involved regions every three days for about four doses. The treatment occasionally causes a temporary accentuation of symptoms for about twenty-four hours and may induce a brief abortive attack in a previously quiescent area.

Onchocerciasis and Loiasis. These two types of filariasis are less common than the above. Onchoceriasis is due to onchocerca volvulus (the blinding filaria): patients show tender subcutaneous nodules, especially on the head, and sometimes keratitis and blindness; an itching lichenoid dermatitis may develop. It is seen in West Africa, and Central and South America. Loiasis is due to filaria loa loa: patients have subcutaneous swellings; and the parasite may migrate to the subconjunctival tissues. Note that the "blinding" filaria causes intrinsic eye changes due to migration of microfilariae into the eye structures, while the loa loa merely causes temporary inconvenience (when the worm passes across the subconjunctival tissues—a rather striking episode, well recorded in colored motion pictures.)

Dracontiasis. This is due to Dracunculus medinensis, the guinea worm, formerly classified as filaria medinensis, and considered in this section for that reason. The male worm is about 2 cm. in length, and the female from 15 to 100 cm.. Each measures from 1 to 2 mm. in diameter. They may produce no symptoms until the skin is punctured over them, usually at the point of emergence of the head. If retained after it dies, the worm often calcifies and appears as a segmented, linear or coiled shadow. The worms have been found in various parts of the body, especially in the subcutaneous tissues.

DISTOMIASIS

This group of diseases is due to trematodes or flukes. *Intestinal distomiasis* is due to a variety of trematodes, especially fasciolopsis buski. In the latter type, oedema may supervene on prolonged diarrhea.

Hepatic distomiasis is due commonly to clonorchis sinensis. Liver enlargement, jaundice, etc., are seen.

Pulmonary distomiasis is due to Paragonimus westermanii. The worm is actually found in many of the organs besides the lung, but pulmonary symptoms tend to predominate. Ova may be recovered from both sputa and excreta: they are small, brown and operculated (measuring from 65 to 100 microns in length). The fluke itself measures about 8 mm. in length and 2 mm. in thickness. In chronic cases it causes small cystic lesions in the lungs, with associated inflammation and ulceration. Roentgenograms may reveal nodular thickening of the pulmonary markings, especially in the lower lobes, with variable degrees of bronchiectasis and even cavitation. The concomitant blood spitting gives rise to the term "endemic hemoptysis." Undoubtedly a better term is *paragonimiasis*.[8] The following four clinical types are recognized: 1. A generalized lymphonodular type, with fever, adenopathy and cutaneous ulceration; 2. A pulmonary type with cough, chest pain, bloody or purulent sputum and variable roentgen findings in the lungs; 3. An abdominal type, with pain, tenderness, variable degree of diarrhea, hepatomegaly and other findings; and 4. A

cerebral type, with various convulsive, paretic or other findings. It is reported that in some sections of Japan, cerebral paragonimiasis is included in the routine differental diagnosis of cases of epilepsy.

We have seen some eight cases of pulmonary paragonimiasis in personnel returning from the South Pacific area, and have made complete roentgen examinations of the lungs of all of them. Only 2 showed significant degrees of nodular thickening of the basal pulmonary markings bilaterally. The findings were not in the least diagnostic per se, but in conjunction with the history of intermittent cough and hemoptysis plus appropriate exposure, they were of some value in diagnosis. In all eight cases, the eggs were found in the sputa. None showed gross bronchiectasis, nor were the "shadows of the fluke" ever visible in any of the films. Miller and Wilber[9] have described in detail the clinical features of 3 of these cases, and are responsible for bringing this unusual condition to our attention. In two of their cases severe and persistent thrombophlebitis of the legs was present. In none were cerebral symptoms prominent.

Schistosomiasis. This is due to a group of blood flukes. Three types are seen in men: Bilharziasis or endemic hematuria, due to schistosoma hematobium; Rectal or intestinal bilharziasis, due to S. mansoni; and Oriental schistosomiasis, due to S. japonicum (with which type liver symptoms predominate).

In infected countries, a high percentage of the population is afflicted with bilharzia (native involvement running up to 60 per cent). The mode of infection is through an abrasion in the skin. All organs of the body are affected, the genito-urinary and gastro-intestinal tracts being the most commonly and most severely involved. The clinical diagnosis is said to be simple, the principal symptom being bleeding from the urinary or gastro-intestinal tract. The diagnosis is confirmed by finding the ova in the excreta. The ova become deposited in the submucosa, giving rise to ulceration and subsequent caldification, which can be shown roentgenographically. Two forms of reaction are observed: (1) calcific streaks in the walls of involved areas, (2) oval densities like stones or calcified papillomata.

The first form is predominant in the bladder and ureters. The second form is found commonly in the intestines and the kidneys. Papillomas in the intestinal tract are not usually calcified, except in the region of the appendix. Those occurring in the kidneys are usually calcified, causing shadows which resemble stones. The calcifications in the urinary tract are fixed in position and may not increase in size even in the course of years. They do not encroach on the lumen, as they are embedded in the mucosa. The calcified papillomas are readily seen roentgenographically, the uncalcified ones by the aid of opaque media. The bladder is usually the first organ to show evidence of the disease.[10]

Cases of pulmonary nodulation, due to ova or adult worms reaching the lungs, and resembling miliary tuberculosis, have been reported in both the urinary (S. hematobium), and the intestinal (S. mansoni) forms of the disease.[11,12]

TENIASIS

This group of diseases is due to cestodes or tapeworms. a. Diphyllobothrium latum, the broad tapeworm, causes few serious symptoms except anemia. It measures from 2 to 10 meters in length. b. Taenia solium, the pork tapeworm, causes variable symptoms, usually mild. It measures about 2.5 cm. long. Its larval form, the cysticercus callulosae, causes *cysticercosis.* Cysticercosis is usually acquired by eating "measly" pork, and may be associated with serious symptoms. The larvae may occur in any organ in the body, but especially in the brain and eye, any symptoms vary accordingly. In the brain, they may cause epilepsy; in the eye, visual aberration; in the muscles rheumatism, and so forth. When calcified, which usually takes five years or more after infestation, the larvae become visible on roentgenograms. In the brain they show as small opacities, 1-3 mm. diameter, scattered through the substance of the organ. In the muscles (where they are much more apt to become calcified than in the brain) they usually appear as ovoid densities, about 2 x 10 mm. in size, lying in the direction of the muscle fibres They range from one to several thousand in a single patient, and may vary greatly in size and shape.[13,14] In the differential diagnosis of brain lesions, tuberous sclerosis may be considered but does not show any associated skeletal muscle calcifications. There are other unusual inflammatory and degenerative cerebral conditions in which patchy calcification occurs, but space does not permit consideration of them here. In the differential diagnosis of muscle calcifications there is usually little difficulty: in trichinosis they are only about 1 mm. diameter; in calcinosis interstitialis they are usually linear and diffuse. c. Taenia saginata, the beef tapeworm, occurs in man only in adult form, and is not associated with any specific findings of immediate interest.

d. Taenia echinococcus (now known as Echinococcus granulosus), the dog tapeworm, is seen in man only in its larval form, and causes hydatid disease or *echinococcosis.* While not strictly speaking a tropical disease, this condition occurs sufficiently often in persons returning from overseas (especially Australia and Iceland) to be worth considering here. The echinococcus cyst or hydatid is formed by liquefaction of the larva after it has invaded the tissues. It grows slowly and its wall is composed of two layers, an external laminated cuticle and an internal germative layer (a fact of diagnostic value in some pulmonary hydatids[15]). The cysts may be simple or complex: some are sterile, some become secondarily infected. They may rupture into hollow viscera, such as bronchi, intestinal tract, biliary tree and urinary tract.

Hydatid cysts occur most frequently in the liver (over 50 per cent of cases). They also occur in the lungs, pleura, abdominal viscera, bones and, rarely, in the nervous and cardiovascular systems. Some are small and symptomless, others are large and produce serious symptoms. In solid viscera, such as the liver, cysts tend to undergo calcification of their walls, while in non-resistant organs, such as the lungs, they rarely or never do so. In bone, a patchy cystic appearance develops, resembling fibrocystic disease or osteolytic metastatic carcinoma; the ribs and pelvis are common sites. In the brain they have been diagnosed by aspiration and air filling. In the lungs, well defined circular opacities occur; they may be quite large but usually vary from 3 to 8 cm. in diameter. Bone and lung lesions may coexist.

TROPICAL TREPONEMATOSES

This group includes yaws, pinta and bejel, all granulomatus diseases due to treponemata, and rarely seen in this country. In their chronic or late stages, lesions of bones and viscera may occur, *similar to those seen in syphilis.* We have seen a case of *yaws* in an officer who accidentally infected a finger while in the South Pacific area. He developed a nodular granuloma at the site of inoculation, with regional adenopathy, and a rash; treponema pertenue was found on dark field study. The lesion regressed promptly with bismuth treatment. In some endemic areas, peculiar tertiary forms of yaws are seen: (a) goundou, a chronic sclerosing osteoperiostitis of the superior maxillae, and (b) gangosa, a destructive ulcerating process of the nose and palate, especially of the cartilaginous portions. Cangosa may be also due in rare instances to cutaneous leishmaniasis. The x-ray appearance of such advanced lesions is readily visualized.

Pinta, due to the treponema carateum, is seen in Cuba, Mexico, and Central and South America. It may result in various viscera lesions, including aortic aneurysm, similar to those of tertiary syphilis. There are no characteristic roentgen findings.

MISCELLANEOUS LESIONS

Tropical Ulcers: Various types of tropical ulcers (sloughing phagendena) may be encountered, especially of the feet, hands and face. These are commonly due to spirochetal and bacillary organisms. They often extend to adjacent bones and joints. X-ray changes are those of severe infectious osteitis or osteoarthritis. In recent months there have been reports of pathogenic diphtheria bacilli being found in some tropical ulcers and desert sores. These have occasionally been virulent and associated with characteristic paralysis and other symptoms.

Ainhum is clinically equivalent to spontaneous amputation of the little toe; it is apparently a neurotrophic disorder. Films show atrophy or disappearance of the phalanges.

Madura foot or mycetoma, is a fungus infection, usually involving the foot and resulting in chronic swelling, ulceration and sinus formation. The bones and joints show varying degrees of destruction and osteoporosis.

SUMMARY

The radiologist can be of significant assistance in the diagnosis of several tropical disorders, by paying due attention to certain disturbances of spleen, liver, intestinal tract and lung. In occasional instances, lesions of bone, brain and eye will provide a clue to the nature of the underlying condition

The principal roentgen diagnostic points of several tropical and subtropical conditions are outlined briefly in this article. The beneficial effects of radiation therapy in connection with a few of the diseases is mentioned.

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Time is of the essence of the damage in shock. Treat promptly; still better, recognize early.

Be not the niggard, nor yet the zealot, in treating shock. Enormous quantities of parenteral fluids may be required; yet they must be judiciously chosen in quality and quantity.

A STUDY OF PNEUMONIA IN SAN FRANCISCO, 1943-1944*

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Introduction.—It is the purpose of this paper to review 150 patients with pneumonia entering a medical service (University of California) at the San Francisco Hospital in the twelve-month period from July, 1943, to July, 1944.

It must be mentioned that many of these patients had a subnormal general condition in association with alcoholism, and came from a low economic level.

No patients were included in this series whose diagnosis was in doubt or whose pneumonia was definitely secondary to other disease processes. In all cases the diagnosis of pneumonia was substantiated by a positive x-ray of the chest.

ETIOLOGICAL CLASSIFICATION

Of the total of 150 patients, 139, (92.6 per cent were due to the pneumococcus; 5 (3.3 per cent) were considered as being primary atypical pneumonia (virus), and 3 (2.0 per cent) were caused by Friedlander A bacillus. There were 2 cases due to Bacteriodes organisms, and one due to beta hemolytic streptococcus. (Table 1.)

TABLE 1.—*Etiological Classification of 150 Cases of Pneumonia.*

	Number cases	Number deaths	% Mortality
Pneumococcal	139	31	22.3
Primary Atypical Pneumonia	5	0	0.0
Friedlander A	3	0	0.0
Streptococcus	1	0	0.0
Bacteriodes	2	2	100.0
Total	150	33	22.0

Since the pneumococcus was responsible for the majority of the cases of pneumonia (92.6 per cent) they will be discussed in detail. Other etiological agents were responsible in too few cases to warrant discussion.

Of the 139 cases of pneumococcus pneumonia, 71.2 per cent occurred in men, and 28.8 per cent in women. Approximately two-thirds of the men and one-half of the women were over the age of 40, indicating that an older age group was involved.

Among the 139 patients, typeable pneumococci were isolated in 105. The remaining 34 patients either died before pneumococcus typing could be done or their sputa would not type. Pneumococcus type VII produced the highest incidence, being found in 21.9 per cent of the 105 patients. Type I was the etiologic agent in 19.1 per cent, and Type XXV and Type IV were each responsible for 6.6 per cent. The remaining types were fairly equally scattered among the rest of the series. One case was due to the relatively rare Buckley strain. (Table III.)

In the four-month period from December through March 59 per cent of the cases occurred. There was no definite monthly or seasoned correlation with any specific pneumococcus type.

TREATMENT

All patients with pneumococcus pneumonia were treated with sulfonamides. Sulfadiazine was used in the majority

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